Supplemental Materials

for

The Impact of an Interactive Statistics Module on Novices’ Development of Scientific Process Skills and Attitudes in a First-Semester Research Foundations Course

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Appendix 1: PowerPoint lecture notes accompanying session one.

Complete lecture materials for session one can be accessed by downloading the “1137_Appendix 1_Final” PowerPoint accompanying this manuscript.
Appendix 2: PowerPoint lecture slides accompanying session two.

Complete lecture materials for session two can be accessed by downloading the “1137_Appendix 2_Final” PowerPoint accompanying this manuscript.
Appendix 3: Rubric for evaluation of student team presentations (session two).

Evaluation Rubric – Group Exercise (Statistics Session 2):

Answering “no” to any of the following questions indicates deficiencies in group performance and comprehension and identifies areas for future review and focus. These guidelines were not used in a formalized scoring context. These guidelines were used as a real-time mechanism to guide instructor questions and prompts during the group reporting session for the article data analysis exercise presented in Session 2.

1. Group Member Participation:
   a. Did each group member actively participate in the discussion of the paper?
   b. When asking questions of non-speaker group members, were questions readily answered? If not, did non-speaker group members supply assistance?

2. Defining Unfamiliar Terms:
   a. Were group members able to offer a definition of figure-specific vocabulary (standard deviation, population, sample, error bar, etc.)?

3. Graphical Literacy:
   a. Were group members able to identify the elements of information on the assigned figure?
   b. Were group members able to identify additional information contained within the text of the figure captions?
   c. Were group members able to summarize the information represented?

4. Integration of Results:
   a. Were group members able to draw conclusions with respect to the contribution of the findings relative to the authors’ hypothesis/null hypothesis?
   b. Were group members able to accurately describe the contribution of each set of experimental results to the validation of the authors’ hypothesis?
Appendix 4: Comprehensive instructional overview of the SCI 1301 statistics module.

<table>
<thead>
<tr>
<th>Pre-Session (15 min. – occurs outside of formal classroom context)</th>
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<tbody>
<tr>
<td>• Collect student self-reported gender and height data</td>
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<tr>
<td>• Generate and print a comprehensive spreadsheet containing all height data for the purposes of classroom distribution (optional; see Appendix 1 notes)</td>
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<tr>
<td>• Demarcate height bins</td>
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<tr>
<th>Intra-Session (80 min.)</th>
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<tbody>
<tr>
<td>• Administer pre-module diagnostics (E-EDAT, GI, and SPLG)</td>
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<tr>
<td>• Provide an introduction to descriptive statistics (Appendix 1 lecture)</td>
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<tr>
<td>• Engage students in the interactive height exercise followed by class discussion</td>
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<tr>
<td>• Provide an introduction to inferential statistics (Appendix 1 lecture)</td>
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<tr>
<td>• Revisit the interactive height activity in light of new knowledge, and conclude the session with a whole-class discussion and review</td>
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<tr>
<th>Post-Session (15 min. – occurs outside of formal classroom context)</th>
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<tr>
<td>• Assign students a pre-selected, peer-reviewed scientific article to read in preparation for the subsequent session (optional depending upon whether the article was previously assigned for homework)</td>
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<td>• Prepare printouts of the manuscript for student use in session two (optional)</td>
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<tr>
<th>Pre-Session (15 min. – occurs outside of formal classroom context)</th>
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<tr>
<td>• Create teams of four to five (ideally) students each if you have not done so already and/or if the physical layout of your classroom restricts the natural formation of groups</td>
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<tr>
<th>Intra-Session (80 min.)</th>
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<tbody>
<tr>
<td>• Review material presented in session one (gallery walk: Appendix 2, slide 1)</td>
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<tr>
<td>• Provide an introduction to hypothesis testing (Appendix 2 lecture)</td>
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<tr>
<td>• Randomly assign one figure from the pre-selected article to each student team</td>
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<tr>
<td>• Instruct students to complete the graphic interpretation exercise (Appendix 2, slide 8), and subsequently engage students in a whole-class discussion</td>
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<tr>
<td>• Administer post-module diagnostics (E-EDAT, GI, and SPLG)</td>
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<th>Post-Session (15 min. – occurs outside of formal classroom context)</th>
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<tr>
<td>• Assign students a second peer-reviewed scientific article (one that they are not familiar with), and ask them to respond to the “In-Class Assignment” prompts presented in the Appendix 2 lecture (slide 8) (optional extension exercise)</td>
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<tr>
<td>• Solicit additional, written feedback on the statistics module (optional)</td>
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Appendix 5: GI and E-EDAT assessments.

Graphical Interpretation (GI) Assessment

Instructions: Please take a moment to review the figure below and answer the questions that follow to the best of your ability.

1. What question is being asked by the authors?

2. Briefly describe the standard error of the means (SEM) for the control and experimental groups. What information does the SEM value provide?

3. During which time point(s) is there a statistically significant difference between the group of neurons receiving the drug and the group not receiving the drug? How do you know?

4. Given the evidence presented above, how confident are you in your ability to accept or reject the null hypothesis? Why?
Expanded Experimental Design Ability Tool (E-EDAT)

A complete version of the E-EDAT, including the E-EDAT scoring rubric, can be located [here](Brownell et al., 2014).
Appendix 6: SPLG survey.

Instructions: This questionnaire consists of statements about your attitude towards statistics. There are no correct or incorrect responses. Please read each statement carefully, and then indicate your level of agreement with the statement. Marking “A” indicates that you are not confident about the statement, whereas marking “E” indicates that you are extremely confident about the statement. Please answer all questions to the best of your ability.

1. I know when to accept or reject the null hypothesis.
   (Not confident) A   B   C   D   E (Extremely confident)

2. I can identify the null and alternative hypotheses in a research article.
   (Not confident) A   B   C   D   E (Extremely confident)

3. I understand the importance of sample size.
   (Not confident) A   B   C   D   E (Extremely confident)

4. I can identify the appropriate target sample population.
   (Not confident) A   B   C   D   E (Extremely confident)

5. I can interpret p-values.
   (Not confident) A   B   C   D   E (Extremely confident)

6. I can explain $\alpha$-values.
   (Not confident) A   B   C   D   E (Extremely confident)

7. I can interpret the meaning of an error bar.
   (Not confident) A   B   C   D   E (Extremely confident)

8. I know the difference between Type I and Type II errors.
   (Not confident) A   B   C   D   E (Extremely confident)

9. I can explain if results from a research study support or reject the null hypothesis.
   (Not confident) A   B   C   D   E (Extremely confident)

10. I can use statistics to analyze data and arguments in my daily life.
    (Not confident) A   B   C   D   E (Extremely confident)

11. I can apply the idea of hypothesis testing to real life situations.
    (Not confident) A   B   C   D   E (Extremely confident)
Instructions: Please indicate your level of agreement with each statement below. Marking “A” indicates that you found the activity to **not be helpful**, whereas marking “E” indicates that you found the activity to be **extremely helpful**. Please answer all questions to the best of your ability.

To what degree were the following activities helpful in improving your understanding of statistics?:

1. **Evaluating results from journal articles.**

   (Not helpful) A  B  C  D  E (Extremely helpful)

2. **Completing the “height” activity.**

   (Not helpful) A  B  C  D  E (Extremely helpful)

3. **Instructor information session.**

   (Not helpful) A  B  C  D  E (Extremely helpful)

Instructions: Please indicate your level of agreement with each statement. Marking “A” indicates that you found the activity to **not be interesting**, whereas marking “E” indicates that you found the activity to be **extremely interesting**. Please answer all questions to the best of your ability.

To what degree were the following activities interesting?:

1. **Evaluating results from journal articles.**

   (Not interesting) A  B  C  D  E (Extremely interesting)

2. **Completing the “height” activity.**

   (Not interesting) A  B  C  D  E (Extremely interesting)

3. **Instructor information session.**

   (Not interesting) A  B  C  D  E (Extremely interesting)

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1 Assessment items regarding helpfulness and interest level of module activities were presented only on the post-SPLG survey.
Appendix 7: GI scoring rubric.

**Question #1 (Total of 1 pt. Possible)**
1 pt. – Correct identification of research question (e.g., what impact does administration of drug X have on neuron activation over time?)

0 pts. – Incorrect question or no response

**Question #2 (Total of 3 pts. Possible)**
1 pt. – Correct definition of SEM is provided

1 pt. – Correct description/explanation for control group SEM is provided

1 pt. – Correct description/explanation for experimental group SEM is provided

**Question #3 (Total of 2 pts. Possible)**
0.5 pts. – Correct identification of “Time 1” as representing a statistically significant difference between control and experimental groups

0.5 pts – Correct identification of “Time 3” as representing a statistically significant difference between control and experimental groups

1 pt. – Correct interpretation of p-values for “Time 1” and “Time 3” as an indication of statistically significant differences between the control and experimental groups at each time point

**Question #4 (Total of 1 pt. Possible)**
0.5 pts. – Student indicates limited confidence in drawing conclusions due, potentially, to concerns regarding limited sample size, need for repeated experimentation, etc. (see below)

0.5 pts. – Indication is provided that limited sample size makes it difficult to determine the validity and/or reliability of results (considering SEM and p-values provided). Need for additional replicates is also an acceptable response.

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2 It is important to note that there is no singular, “correct” response to this second item. Students might state, for instance, that there is a higher degree of variance reported for experimental outcomes vs. control outcomes, as reflected in the SEM data. However, we recommend that the instructor use his or her own discretion in determining the sufficiency of student responses given the extent to which SEM has been discussed in the context of their course. For a standard definition/description of SEM, please visit the following site: [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1255808/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1255808/). No partial credit was awarded for any response.